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A SKETCH OF GEOLOGICAL INVESTIGATIONS IN MINNESOTA.

PRIOR to the beginning of geological investigations in Minnesota there was a period of exploration and travel, in the published accounts of which are some references to the strictly geological features of the state,¹ and others from which some inferences can be drawn bearing upon the natural features and often upon the geology. Omitting the references made by Champlain in 1615 to the "Grand Lac" and the explorations made by Grosselliers and Radisson between Hudson's Bay and Lake Superior in 1659, and the maps of Franquelin dated 1688, and Beauharnois, dated 1737, it is sufficient here to mention only the discovery of the Falls of St. Anthony by Father Hennepin who accompanied Accault in an expedition up the Mississippi, sent out by La Salle, in 1680. Hennepin's original account of the falls has been used as a datum from which to calculate the amount of recession from their discovery to 1857. This important geological phenomenon was viewed through the eyes of a religious enthusiast, and he named them in honor of St. Anthony of Padua, his adopted patron saint. Sieur Du Luth about the same time was making some additions to the known geography of the state. In 1683 Le Sueur made the earliest examination of the valley of the Minnesota. He mentioned a "green earth," which he supposed to be carbonate of copper, at a point near Mankato, and a large mass of native copper on Lake St. Croix. Jonathan Carver traveled extensively in Minnesota in 1766. He gave a full description and an illustration of the Falls of St. Anthony, which have served to

¹ There is a "sketch of explorations and surveys in Minnesota" in Vol. I. of the final report of the present "Geological and Natural History Survey" of the state. This deals largely with the early explorations. In Bulletin No. 1, of the same survey, will be found some account of the institution and progress of the present survey.

fix their position at that date. He makes the first mention of the red pipestone, or catlinite, of the southwestern part of the state.

Following these early travels was a period of territorial exploration, extending from 1783 to 1858. When the War of the Revolution closed the area which now comprises the state of Minnesota was divided between the French and the United States. From 1783 till the expedition of Lieutenant Z. M. Pike, of the United States army, which took place in 1805, the Upper Mississippi region was left almost as it had been under the British, whose fur-traders still overran the region and still floated the British flag at their trading-posts or "forts." During this period, however, an indefatigable English geographer crossed the northern part of the state and recorded his observations of latitude, depositing his notebooks with the Northwest Fur Company, by whom he was employed. These records have remained unpublished until recently.¹ The work of this geographer, whose name was David Thompson, resulted in determining the fact that the northern source of the Mississippi was not north of the Lake of the Woods, where it was assumed to be by the treaty of 1783. He reached Turtle Lake, the "Julian sources" of the Mississippi, according to Beltrami, twenty-five years before that gentleman saw the lake, and recorded the latitude of the Mississippi at Red Cedar (now Cass) Lake. Lieutenant Z. M. Pike in 1805 measured and described the Falls of St. Anthony. This description, as it is accompanied by a map of the river and cataract, has served to fix the position of the falls at that date. He also described briefly the Falls of Pokegama. In 1871 Major S. H. Long again visited and described the Falls of St. Anthony, giving some notes on the nature of the rocks that cause them. In 1820, and again in 1832, Mr. H. R. Schoolcraft was in Minnesota in the employ of the United States government. He was the first to give a geo-

¹ E. D. NEILL. *History of Minnesota*, fourth edition, p. 866. Minneapolis, 1882. Mr. J. B. TYRRELL has more recently published these notes in the *Proceedings of the Canadian Institute*, March (published October), 1888.

logical account of the lower valley of the St. Louis River. The rock at the Falls of St. Anthony he considered Lower Carboniferous; *i. e.*, of the same age as the lead-bearing Mountain Limestone of England. In 1832 he discovered the source of the Mississippi River and named it Lake Itasca, an imaginary name of an imaginary Indian divinity, constructed by him for the occasion from the two Latin words *veritas*, truth, or true, and *caput*, head, by taking two syllables of the former and one of the latter. By this he intended to indicate that Lake Itasca is the *true head* of the Mississippi. Beyond this signal discovery and a picture of the Falls of St. Anthony, Schoolcraft added but little to the geography or geology of the state. He should, however, have credit for noting the occurrence of crystalline rocks at several points in the Mississippi River below the Falls of Pokegama.

Keating's narrative of Major Long's expedition in 1823 to the source of the St. Peter's River contains much on the geology of the route. Besides an account of the Falls of St. Anthony, Professor Keating gives the first geological description of the valley of the Minnesota River (then called St. Peter's) and of the *coteau des prairies*. Descending the Red River of the North to Winnipeg, this party turned eastward, crossed the Lake of the Woods, ascending Rainy River and Rainy Lake, thence following the international boundary line to the east end of Sturgeon Island where they turned more northward, in order to reach Fort William by another route. Keating was a chemist and a mineralogist, and his notes on the crystalline rocks of the route afford the first instance of the application of the correct and careful methods of modern science to the investigation of the geology of the state. It was a reconnoissance simply, and but few facts could be noted, but such as they are they have been found, in the main, to be reliable.

Lieutenant James Allen, who accompanied Schoolcraft in 1832, rendered an independent report of the expedition, in which he gives brief descriptions of the topography and general features, including the dalles of trap-rock on the St. Croix river.

G. W. Featherstonhaugh was the first professional geologist, so far as known, who made the state a visit. He was an English gentleman and was commissioned "U. S. Geologist" by Col. J. J. Abert, of the bureau of topographical engineers. He was accompanied in 1835 by Mr. W. W. Mather who afterwards became known as a geologist of the state surveys of Ohio and New York, but they parted by reason of some disagreement, and Mather returned alone from some point on the upper waters of the Minnesota river. It is possible that Mr. Featherstonhaugh's geological report suffered materially in thus being deprived of the services of Mr. Mather who retained his geological notes. The manuscript of Mr. Mather, not published, was said to have been in existence for some years after the report of Mr. Featherstonhaugh was issued, but for many years it has been lost. Mr. Featherstonhaugh's report, published at Washington, was largely a general treatise on geology, but contains many new and interesting facts relating to the physical features of the country, including an account of the Falls of St. Anthony. He visited the place of Le Sueur's "copper mine," but concluded that the discovery of copper, as reported by Le Sueur, was one of those fables which the early French travelers sometimes invented in order to gain influence at the court of France. The "Carboniferous limestone" he supposed to extend as far as the bluffs of the Minnesota at Mankato. He ascended the *coteau de prairie*, but he failed to visit the red pipestone quarry situated in the extreme southwest corner of the state.¹

It remained for George Catlin, in 1836, to bring away from its native place, a sample of the red pipestone. This was submitted to Dr. C. T. Jackson, of Boston, who after analysis and description, gave it the name of catlinite.

Joseph Nicolas Nicollet,² from 1836 to 1843 prosecuted geo-

¹ Mr. Featherstonhaugh's report is entitled: "Report of a geological reconnoissance made in 1835 from the seat of government by the way of Green Bay and Wisconsin territory to the *coteau des prairies*, an elevated ridge dividing the Missouri from the St. Peter's River," printed in 1836.

² Additional facts about Nicollet. H. V. WINCHELL, *American Geologist*, Vol. XIII., p. 126, Feb., 1894.

graphical researches in the Northwest. Incidentally he aided greatly in determining some parts of its geology. It was through him that T. A. Conrad obtained fossils from the lead-bearing formations of the Upper Mississippi by which he, first of all, correctly assigned that limestone to the age of the Trenton of New York.¹ Professor James Hall, but little later, examined it in the field, and came to the same conclusion.

The chief event connected with the territorial investigation of the geology of Minnesota was the survey of D. D. Owen, extending from 1847 to 1850, which also covered much contiguous territory. This survey had the resources and the corps of men which enabled it to pronounce finally on some of the mooted questions of the geology of the Upper Mississippi valley, and it was continued long enough to complete at least a reconnoissance of a large area. Its fine quarto volume,² published at Philadelphia by Lippincott, Grambo and Co., contains, besides the report of Dr. Owen, reports by J. G. Norwood, B. F. Shumard, C. Whittlesey and R. Owen. It embraces also a memoir by Joseph Leidy on the extinct mammalia and chelonia of Nebraska Territory, and several valuable appendixes. Dr. Owen's other assistants were J. Evans, B. C. Macy, A. Litton, G. Warren, H. Pratten, F. B. Meek and J. Beal. From this report may be said to date the systematized geology of the state. It laid accurately a broad base on which all future geologists of the state must build. About this time the New York State survey was in vigorous action, and some of its results had been published. Hall, Conrad, Emmons, and Mather, with Hitchcock of Massachusetts contributed indirectly to the final conclusions at which Dr. Owen arrived. The form of the volume is similar to that of the final report of the New York survey, but its breadth of scope is greater and its typographic execution superior. Its illustrations

¹ Observations on the lead-bearing limestone of Wisconsin and descriptions of a new species of trilobites and fifteen new Silurian fossils. T. A. CONRAD. *Proc. Acad. Nat. Sci., Philadelphia*, Vol. I., 1841-43.

² Report of a Geological Survey of Wisconsin, Iowa and Minnesota, and incidentally of a portion of Nebraska territory, by DAVID DALE OWEN, United States geologist, 1852.

and its maps are first-class. It is a well-known work, and can still be seen sometimes offered for sale by dealers. It constituted at that time one of the largest and most expensive publications of the United States government, a monument at once to the learning, the zeal and the wise management of Dr. Owen. It is not necessary here to go into the scientific merits of this volume, since its contributions to the geology of Minnesota and of the Northwest are well known and have entered into the geological literature of the country in many forms.

After this territorial period, ending in 1858, the new state made early attempts at a geological survey, but met with poor success. The first legislature ordered a reprint of portions of the geological report of Professor Daniels on the survey of Wisconsin, Minnesota having formerly been embraced in the territory of Wisconsin. The second legislature instituted a plan for establishing a thorough survey. Messrs. Charles L. Anderson and Thomas Clark were appointed commissioners to report on the geology of the state and on a plan for such survey. They rendered a report the following year, making an octavo pamphlet of twenty-six pages, outlining the proper scope and methods of such a survey. But the legislature took no action, probably because of the objections of Governor Ramsay who considered that the state was not able at that time to bear the cost which the survey would entail. In 1864 a law was passed by the sixth legislature authorizing the governor to appoint and direct a state geologist. The first appointee under this law was Dr. Aug. H. Hanchett. His assistant was Thomas Clark. But little or nothing of value was done by Dr. Hanchett, but Mr. Clark rendered a report of seventy octavo pages on the physical features of that portion of the state bordering on Lake Superior. The next two years the survey was conducted by Mr. H. H. Eames who had his brother, Richard M. Eames, for assistant. Two small annual reports were rendered by Mr. Eames, who was devoted to prosecuting a "mineral hunt" in the northern part of the state. This was apparently in accordance with instructions from Governor Miller. Excitement soon arose over the discov-

ery of small amounts of gold in the schists at Vermilion Lake, and a genuine "boom" (so-called in later years) centred on that region. Much prospecting was done and much money squandered, but little geology resulted from these two years of the administration of Mr. Eames. The state survey collapsed ingloriously, and was not revived till the commencement of the present survey in 1872.

From other sources, however, the geology of Minnesota was kept in a state of progress. Professor James Hall visited the state in 1865, and examined the St. Croix valley with reference to its prospects for copper in the vicinity of Taylor's Falls. This visit was prolonged for the purpose of examining the reputed coal beds of southwestern Minnesota which he found to belong to the Cretaceous system. The next year a report of the trip to the southwestern part of the state was made by Professor Hall. It is published in the Transactions of the Philosophical Society of Philadelphia. This paper embraces the first geological observations ever made on a very large area in the region southwest from the Minnesota River, and may be said to have supplemented and extended the observations of Keating and of Featherstonhaugh. In 1866 also were published the field observations of Colonel Charles Whittlesey made in northern Minnesota in the years 1859 and 1864. These also embodied some more detailed descriptions of the region north of Pokegama Falls, resulting from the survey of D. D. Owen whose assistant Whittlesey was. The papers of James Hall and of Charles Whittlesey constitute the most valuable contributions to the geology of the state during the period following the territorial exploration, and preceding the present survey. There were, however, some later surveys. One was a topographical survey of the Minnesota valley by General G. K. Warren, under the United States government. His reports are to be seen in the Report of the Chief of Engineers for 1867, 1868, and 1874. He first published, with full demonstration, the idea that the valley of the Red River of the North was formerly covered by a freshwater lake which embraced the region of Lake Winnipeg. Professor Henry Youle

Hind had already announced such a hypothesis, but General Warren mapped the area of the lake and assigned a cause for the former drainage toward the south.¹ In 1871 Messrs. W. D. Hurlbut and J. H. Kloos contributed to the geology of Minnesota, the former in the southern part of the state and the latter in the northern. Their papers were published in the *Minnesota Teacher*, although Mr. Kloos contributed an article, in 1872, to the *American Journal of Science*, giving particulars of the discovery of Cretaceous beds with lignite in the valley of the Sauk River, adding palæontological determinations by F. B. Meek.

Professor A. Winchell was appointed by Governor Horace Austin in 1871 to make an examination of the vicinity of Belle Plaine, in Scott county, where indications of brine were said to exist. This was in accordance with an Act of the Legislature of 1870. The report was printed by the Legislature of 1872. It gives a sketch of the geology of the region, including notes on the drillings from the Belle Plaine well, and concludes that probably brine does not exist at Belle Plaine, nor in the rocks below.

The present survey.—The law of the present survey was approved by the governor, March 1, 1872. It is the first instance in which a systematic survey has been placed by any state of the Union, under the direction of the regents of the State University, with requirement to make constant examination and stated reports. It has often happened that the professor of geology in a state institution has been the state geologist, but in those cases he has been directed by some other state board or by the governor. The arrangement which prevailed in Alabama, during the incumbency of Professor Tuomey, of the State University, was in some respects similar, but it was not inaugurated at the instance of the state legislature. It was an incident of his professorship as ordered by the trustees,² and when it was recog-

¹ See the *American Naturalist* for November, 1868.

² E. A. SMITH, *Geological Surveys in Alabama*. JOURNAL OF GEOLOGY, Vol. II., p. 275.

nized by the legislature the explorations were still carried on at the expense of the University of Alabama. When the state later appropriated money to conduct the survey, Professor Tuomey resigned his position in the university. The present survey of Alabama was instituted by law in 1873, although the trustees of the university had required the professor of geology the year previous to revive the plan which was established under Professor Tuomey. The survey as such is not under the direction of the university trustees. The governor, the secretary of state, and the state geologist constitute the board of control.

The plan of the Minnesota survey was recognized at once as a new departure and was thus referred to by a high authority:¹

"We spoke in the June number of the *Popular Science Monthly* of the advantages that would arise from connecting the scientific exploration of the several states with their higher educational institutions. We have been since reminded that this is an accomplished fact in at least one of the states, and we hasten to give credit to Minnesota for having taken this new departure in scientific education. It is one of the youngest states in the Union, and a generation ago was but a land of savages, an indefinite tract in the great "Northwest Territory," beyond the "Wisconsin," beyond the distant Mississippi, that we now see taking the lead of the older states in organizing the new education by devoting her university to the comprehensive and practical study of nature. This step has been but recently taken, and its benefits are prospective, but if thoroughly carried out there can be but little question of the advantages that must arise to the people of the state. . . . The movement in this case, it is evident, has been initiated mainly in the interest of the geological survey, but it is to be hoped that the larger objects of education to which it is a means will not be lost sight of. The university will undoubtedly be benefited by taking the responsibility of the work, but the movement will fall greatly short of the good it might accomplish if it is not vitally connected with the educational system of the state."

This survey has been in uninterrupted progress under its original law from the date of its establishment to the present. It requires the regents not only to conduct a purely geological survey, but also to make a natural history survey, including botany and zoölogy, to construct a topographical map of the state, and to investigate its meteorology. The law establishes a

¹ Editorial in the *Popular Science Monthly*, Vol. III., p. 391, 1873.

museum at the university, which is ordered to be kept in good order and accessible to the public, and provides for the exchange of specimens with other institutions. This law was drafted by President W. W. Folwell, of the University of Minnesota, and is still in force in all its provisions. It was introduced in the Senate by Hon. J. S. Pillsbury, of St. Anthony. The legislature has sometimes passed supplementary laws to facilitate the execution of the main law, or directing the methods of publication of the survey reports, but has in no way changed the original law.

To accomplish this survey *an annual appropriation of one thousand dollars was made by the legislature!* The writer was appointed to conduct it in July, 1872, and tendered his first report December 31, 1872. The funds being so meager, the state geologist was required to earn the greater part of his salary by teaching the natural sciences in the State University, and he held the chair of geology and mineralogy and discharged all its functions, in addition to the work of the survey, until 1878, when the regents made other provision for such instruction. It is apparent, on the slightest consideration, that a state survey based on such a fund would go so slowly that more than a century would lapse before its completion, and that it would not be apt to receive the respect of the people, nor maintain its rank amongst such enterprises. In casting about for some means to establish the survey on a better footing, the writer, when engaged in the field work of the first year's campaign, was much with Hon. W. D. Hurlbut, of Rochester, Minn., and received from him the suggestion that the state lands known as Salt Spring lands, might be made to support the survey. This United States land grant had been the prey of various chimerical schemes for developing imaginary natural resources, and it appeared evident that it would be entirely absorbed by unprincipled and ambitious designers unless it were taken care of by the legislature in such a way as to put the lands beyond their reach. The suggestion of Mr. Hurlbut may have resulted from conversations with the state auditor, Hon. O. P. Whitcomb, who was his townsman, and who was also

friendly to the survey. It is probable, further, that the auditor had conferred with Hon. A. J. Edgerton, then state railroad commissioner, and with the senator (Pillsbury) from St. Anthony, as has been claimed, and that there was, prior to the writer's knowledge, a concerted agreement to devote these lands to the support of the survey.¹ However that may be, the first report of the survey presented the suggestion to the legislature that these lands could be devoted, consistently with the terms of the United States grant, to the maintenance of the survey ordered by the previous legislature. The law that was passed turned these lands over to the custody and control of the regents of the university, with instructions to sell them and devote the proceeds to the support of the geological and natural history survey. Thus the survey was put on a financial basis which promised for it a reasonable duration. When later it was found that there was a large deficit in these lands due to the negligence of the United States officers, and the state was allowed to make re-selections in other portions of its domain, and when such re-selected lands were also devoted by the state to the same purpose, the fund became sufficient, with economy, to keep the enterprise in working activity for several years, and apparently to complete the geological portion. These lands, thus augmented, amounted to 38,643 acres, which could not be sold, according to existing law, for less than five dollars per acre.

In addition to this financial foundation the legislature increased the annual appropriation named in the original law to two thousand dollars, the same to continue until the annual proceeds from the Salt Spring lands should amount to that sum. It was discontinued in 1879. As the sales of the Salt Spring lands did not furnish sufficient revenue the survey became indebted to the university. The legislature, in 1887, appropriated ten thousand dollars. In 1891 it appropriated fifteen thousand dollars, and in 1893 ten thousand dollars.

¹ The writer gives these details because some complaint has reached him that due credit had not been given by him, in an earlier account, to the prior conferences of these public officials.

TOTAL COST OF THE MINNESOTA SURVEY.

Annual appropriations at the commencement of the survey,	-	\$15,000.00
Proceeds of the Salt Spring lands to July 31, 1888,	- -	46,105.07
Legislative appropriation, 1887,	- - - - -	10,000.00
“ “ 1891,	- - - - -	15,000.00
“ “ 1893,	- - - - -	10,000.00
Proceeds of the Salt Spring lands from July 31, 1888, to July 31, 1892,	- - - - -	27,621.09
Total,	- - - - -	\$123,726.16

This covers the expenses of all departments of the survey, which lately has been rendered more active in the lines of botany, zoölogy, and topography than formerly. It also embraces the expenses of the museum and the library, and includes \$12,510.80 expended for the department of instruction in the university prior to 1878. It does not cover the cost of publication of the reports and bulletins. These are executive documents of the state, emanating by law, from the State University, and their publication is provided for by estimates for public printing which are presented to each session of the legislature.

The field work of this survey began in the southern counties and progressed northwardly. But little technical work was attempted at first, the aim being to render work done, as expressed in the reports, acceptable to the people of the state, and thus to the legislature on whose good-will the firm establishment of the enterprise depended. Quicker geological returns were possible in the southern and central counties, which are principally of prairie and settled, than in the northern, which are forested and were then largely in their primeval state. Still the annual reports do not record a steady progress northward, but embrace miscellaneous and often unclassified matter derived from all parts of the state. They average about 250 pages octavo, and have many illustrations. Twenty-two annual reports have been issued. In 1884 the first volume of the “final report” required by the law of the survey, was issued. It is a quarto of 700 pages and 43 plates. It embraced the work of about ten years, so far as it could be made conformable with the plan of

publication adopted. The second volume of the final report, of the same size and style as the first, was published in 1888. This covered substantially the central third portion of the state. These volumes contain no palæontology, but are devoted to a description of the geological features, with frequent references to the economic resources of the areas described. The state is being mapped by counties, and each chapter of these reports is accompanied by a colored and contoured map of the county it describes. There is to be no large atlas in sheets three or more feet square, but a book-atlas, in quarto size, will constitute one of the final volumes, made up of all the county maps, or plates, with brief descriptive text for each. The third volume of the final report has been under way for two or three years. It is devoted to the palæontology of the Lower Silurian, *i. e.*, the formations above the St. Peter sandstone and up to and including the Galena limestone. If there be no interruption of the survey, it will be concluded in the same style by the publication of one other volume (fourth) of the final report, which will present the geology and lithology of the northern part of the state.

In addition to the annual and the final volumes a third serial is maintained, appearing in independent parts at irregular intervals, embracing more carefully considered investigations, which arise in the progress of the general research, which, yet, cannot be accepted as finished, but ought to be preserved. Of these occasional publications, which are called "bulletins," ten have been issued, and the eleventh is in preparation.

The administration of the survey, in all its departments, was, till 1891, in the hands of the writer, but at that date the botanical, the zoölogical, and the topographical departments were erected into independent surveys, and different members of the faculty of the university were appointed to conduct them. It has been the policy of the writer to conduct the survey, as far as possible, in the interests of the people of the state, in the immediate and economical sense. The plans that have been adopted have been almost always submitted to the regents, or their executive committee, prior to their execution. In some instances

certain public or widespread want for information, expressed in correspondence, or in the public press, such as the demand for information concerning the grasshopper plague and the ways and means for alleviating the evil, the call for peat fuel on the woodless prairies, the ravages of insects injurious to horticulture, the general belief in the existence of coal in the state, the demand for authoritative statements founded on scientific data touching the nature and extent of our forests, or the quality of our soils, or the probability of brine for the manufacture of salt, or the existence of the necessary conditions for artesian water or burning-gas, or the quality of our native building stones, or the extent of iron ore deposits and their qualities,—these have all been elements that have influenced the plans formed from year to year. While answering these purposes as nearly as possible, the survey has been rendered useful to numerous individuals by private correspondence, preventing the useless expense of misguided exploration in many instances, and directly influential in promoting economic industry in every case where its aid was solicited and its data could be employed.

In this policy the usefulness of the survey has been brought home to the people of the state, and they have come to regard it as an indispensable adjunct to the university and to the progressive development of the state in its natural resources. This course was politic as well as just. There was nothing more evident, when the survey began, than that it must have the confidence of the people. The people then lived largely in the southern and central portions of the state. The annual reports embraced common, patent facts, and description cast in a semi-scientific mould. As the survey became grounded in the goodwill of our own citizens, it was strengthened for doing more advanced work, and at the same time it found a constituency ready to welcome more scientific publications. It is highly probable that if such a moderate course had not been pursued, the legislature, instead of always manifesting a good-will and determination to have the work well sustained, would have refused the financial aid that has been asked of it, and the enterprise

might have had the short-lived existence that has been the fate of so many other state surveys.

Coöperation of the U. S. Coast and Geodetic Survey.—Under a law of Congress, passed many years ago, the Coast and Geodetic Survey coöperated with such states as had either geological or topographical surveys in progress. This aid consisted in the determination of the latitude and longitude of certain points and the establishment of others by triangulation preparatory to correct mapping. Through the agency of Governor L. F. Hubbard, in 1884, this matter was brought to the attention of the Superintendent of the Coast and Geodetic Survey, and this law of Congress was made operative for the State of Minnesota, and has continued so to the present. That furnished the commencement of the topographical survey which the state law orders. By the combined operation of these laws such triangulation and other field work is authorized as will eventuate in a complete topographical mapping of the state in the most approved methods. This articulation between the two surveys was practically established by Major C. O. Boutelle, an officer of the Coast and Geodetic Survey, and the subsequent conduct of the survey has been under the direction of Professor W. R. Hoag, of the University of Minnesota. This plan not only carries on, with little expense, the required topographical survey, but furnishes to the department of engineering in the university an object lesson in the use of the nicest instruments and some employment for its advanced engineering students—for in all departments of the state survey the law requires the employment of the professors and students of the university when they can be found competent.

The scientific progress of this survey it is not necessary to enter upon, and the writer might not be the best judge if he should attempt to set it forth. Its reports are widely distributed, and its agency, such as it is, in the recent development of the geology of the state, and of the Northwest, is well known.

Conclusion.—It is the custom to “finish” such surveys, but no one who has been cognizant, for twenty years, of the incompleteness of the work which such surveys have to be satisfied

with, and who reluctantly relinquishes from time to time some line of research, or some unsettled problem, in order to devote his energy to the passing events of the general work, will be willing to employ the word *finish* in any other sense than that his time and resources are exhausted, and he must hasten to put in order such data as he may have gathered, ere they be lost by the limitations of human life. Every such survey constitutes a stepping-stone, and only a stepping-stone, to the *finishing* of the geology of the area surveyed, but the end is in the far future, and perhaps in the infinite future. The future stepping-stones toward that end may not be in the manner of formal surveys; but in many ways now unknown, largely through the activity of the professors in the various state institutions who will wrestle with the problems now left unsolved, the intricacies of the geology of the state will be explained more fully. More enlightened public sentiment will furnish multiplied ways and means for more minute work, and the increase of exact knowledge, combined with greater demand for scientific data, will yet carry the geology of the state to a degree of exactness of which we at present can have but a faint conception.

N. H. WINCHELL.